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# TERMS OF REFERENCE

# ESTABLISHMENT OF LOCAL PV SYSTEMS CERTIFICATION CAPABILITY

## BACKGROUND

*<Brief description of solar PV component of ongoing [Donor] project; need to establish local standards and certification capability to ensure performance of installed systems; review of existing local equipment and staffing for certification>*

## OBJECTIVES OF THE PROPOSED TECHNICAL ASSISTANCE SERVICE

The principal objectives are to: (a) establish the capability to certify solar home systems and other PV products by carrying out type testing as well as product testing, (b) monitor systems in the field, and (c) initiate a program that will permit the designated technical agency (DTA) to achieve [Code] certification for PV systems testing. The focus of this technical assistance is PV systems testing and qualification, and in particular, Solar Home System and not PV module testing and qualification. Specific activities to be supported are: establish the PV Systems Test Facility, develop testing and monitoring procedures and train the research and engineering staff and technicians at DTA. The following turn-key services are requested from the contractor:

* Procure test equipment
* Install and commission the equipment at the PV Systems Test Facility at the DTA site.
* Develop/improve PV systems specifications, and test and field monitoring procedures
* Train DTA staff in conducting the tests, and in conducting field monitoring of SHS and based on these findings offer guidance in developing improved designs and specifications.
* Establish quality control, documentation and reporting procedures in accordance with [Code] standards and to develop a time-bound program for DTA to achieve [Code] certification.

## SCOPE OF WORK

*<General Notes: This section of TOR details all the main activities to be conducted by the consultants and expected results of those activities. TOR should describe only the activities, not the approach or methodology by which the results are to be achieved.>*

The scope of work consists of six Tasks:

* Task 1 - Refinement of PV Systems Specifications
* Task 2 - Refinement and Development of Qualification Test Procedures
* Task 3 - Procurement and Installation of Testing Equipment
* Task 4 - Qualification Testing
* Task 5 - Field Performance Monitoring
* Task 6 - Training
* Task 7 - Preparation of Program for Obtaining [Code] Certification

### Task 1 - Refinement of PV Systems Specifications

The refinement of SHS specifications will use as a starting point, the SHS specifications prepared for procurement under the SHS Project. In addition, specifications for, DC/AC inverters and DC/DC voltage converters should be added to the SHS Project specifications. Refinement of specifications for other stand-alone PV systems or components such as vaccine refrigerators is encouraged.

### Task 2 - Development of Qualification Test Procedures

The contractor will work with DTA staff to develop testing and qualification procedures for PV systems and components specified in Task 1. To the extent possible the testing procedures will build upon internationally accepted standards.

The contractor will refine testing procedures already developed locally and develop required procedures for other components. Development of procedures for overall system testing is important and they should incorporate the systems testing procedures currently under development. In addition, refinement/development of test procedures for assessing the performance of black and white, color TV, inverters etc., is required.

### Task 3 - Procurement and Installation of Testing Equipment

The contractor will procure and install test equipment needed to conduct the qualification tests developed in Task 2. This equipment will supplement those already available DTA facilities. The contractor could supply the specified equipment or alternative equipment that is substantially equivalent. The contractor may also offer additional equipment, as an option. As a turn-key installation, the contractor will be responsible for the successful installation and commissioning of all test equipment. DTA staff will be available to assist in installation of the equipment.

### Task 4 - Qualification Testing

The purpose of the performance and qualification tests is six fold:

1. Offer type testing and product testing services to Indonesian and international suppliers;
2. Select the best components, equipment, appliances and systems suitable for [Country];
3. Establish the life performance of equipment through the use of accelerated aging tests, climate tests and (optional) mechanical tests;
4. Examine the modes of failure in order to improve the quality and reliability of components and PV systems;
5. Improve specifications; and
6. Improve PV systems reliability and performance.

It is expected that several kinds of tests will be required:

* Performance qualification tests of each component or equipment.
* Tests of the complete SHS system to evaluate the influence between components of a system under simulated field conditions. It is expected that about [Number] samples of SHS will be purchased from dealer-suppliers who are participating in the SHS Project and from other sources and be installed and tested at the Test Facility under simulated use conditions.
* Aging tests (lights, batteries, controllers and batteries from participating dealer-suppliers, etc.) in the laboratory under simulated field conditions, as well as optional climate tests.
* Optional mechanical tests.

The proposed Test Facility will include (i) meteorological data collection stations, (ii) battery performance monitoring and aging effects assessment test stand, (iii) stations that can be adapted for testing various types of components (using the existing 0.6 to 6 kWp PV array field ), (iv) environmental test stations, and (v) complete PV systems test stations. It is expected that the equipment list in Annex 5 would be supplemented by existing BPPT equipment in order to implement all test procedures.

#### Performance Qualification Tests of Components

These tests are expected to include the following:

* Meteorological data: direct and diffuse insolation, wind speed, temperature, humidity.
* PV module: Outdoor I-V. measurements, open circuit voltage, short circuit current, Vmax, Imax, Noct, standardizing of output to STC conditions, and by measurement against a reference module which has been calibrated using [Code]-series test procedures.
* Batteries: Capacity, cycle life, self-discharge rate, efficiency, etc.
* Controllers: low voltage disconnection and reconnection, high voltage algorithm, maximum current handling capacity, etc.
* Lights: luminous efficacy, minimum and maximum operating voltage, wave form voltage symmetry, maximum crest factor, aging effects, temperature-humidity-corrosion, etc.
* DC/DC converters: Efficiency over the output voltage range, stand-by consumption, maximum power, etc.
* Inverters: efficiency, harmonic distortion, peak power ratings (short term and continuous ratings), performance under different inductive and resistive load conditions, etc.

In addition, for black and white and color TV sets typically used in SHS, energy consumption, maximum peak amperage, average amperage, minimum and maximum operating voltage, stand-by consumption, etc., will be measured to assess and report on the comparative performance of TV models.

#### Complete PV System Tests

The complete solar home systems, including the appliances and all components, will be tested in order to evaluate interface problems, influence between components, and overall system performance, reliability and life. The installation will be as similar as possible with the average installations in the SHS Project. These tests are especially important and should evaluate the performance, reliability and system/component life under expected field conditions. The contractor should propose the system test procedures to be used. It is expected that the test procedures will build upon and incorporate the system qualification test procedures.

#### Aging Tests

Humidity, high ambient temperatures, corrosion and dust are concerns in Indonesia. The main problems expected are delamination, corrosion of connections, electro corrosion of PV modules; corrosion of mechanical parts and electronic cards and components, and dust intrusion of controllers, connection boxes, inverters, lights. The existing 300 liter climate chamber for temperature-humidity tests and the optional salt-mist and dust test chambers for corrosion and dust tests can be used.

The following components or systems will be tested under ambient and elevated temperature and humidity conditions:

* Lights: The life-time test of fluorescent lights will follow applicable [Regulation] norms.
* Controllers and inverters: Life-time and performance will be tested as per [Regulation] norms where available
* SHS: Different SHS configurations used in the SHS Project will be procured and installed at the Test Facility. The use of lights and TV, etc. will be simulated using actual appliances and timers to assess the performance of the system over a period of time. [Code] testing procedures will be used where applicable.

The accelerated aging tests are important especially with batteries that are expected to have a life time up to ten years (e.g., tubular plates stationary batteries). These tests can give results in shorter periods of time. The battery tests will be conducted according to internationally accepted procedures such as [Code] (draft) standard.

#### Optional Mechanical tests

Optionally, vibration and shock tests could be proposed to simulate transport conditions.

A key requirement during qualification testing is that DTA staff be fully trained in all aspects of testing, results evaluation, quality assurance, documentation and in reporting in accordance with [Code] standards. The success of this technical assistance will be judged by the extent to which DTA staff can independently and competently conduct the testing and provide the necessary reports, at the end of the period of performance of this contract.

### Task 5 - Field Performance Monitoring

About 20 solar home systems installed in [Region 1 and Region 2] under the SHS Project will be instrumented and data loggers will be used to measure key performance parameters. The module performance will be measured and standardized using the reference module. The purpose of the monitoring is to determine whether these systems are performing as expected and to provide feedback for future improvements. Data to be recorded daily are: battery state of charge, battery voltage, module current, energy consumed, battery temperature, module output without regulation and with regulation, etc.

The contractor will develop the procedures for monitoring the SHS installed in the field. They will assist DTA staff in training personnel in the field who will be responsible for the actual field data collection. The contractor will prepare data analysis and reporting software and procedures. They will assist DTA staff in applying these procedures to prepare the first set of reports. When necessary, and on a limited basis, the contractor will assist in trouble shooting and advising DTA and field staff.

### Task 6 - Training

Due to new test procedures and equipment, training will be essential for the effectiveness of the Test Facility. Although listed as a separate task, training for the most part will be conducted on-the-job. It should be emphasized that priority is to be given for on-the-job training and less to formal courses or training classes. Elements of training to be considered are:

* Training at the Test Facility by technicians from the suppliers to train the staff on proper use of equipment
* Training by the contractor during implementation of the test procedures. The training will include sampling procedures to be used for selection of samples, testing, evaluation, documentation and reporting.
* Training of selected Test Facility staff at laboratories overseas to give them experience in working with technicians and scientists in laboratories where testing of SHS, batteries, modules has been carried for a long time.
* Training of field staff responsible for conducting the field data collection as noted in Task 5 - Field Monitoring.

## DELIVERABLES & SCHEDULE

*<General Note: The assignment reporting requirements should be clearly specified and balanced. Consultants should not be forced to spend an excessive amount of time preparing minor reports. TOR may also indicate the formant, frequency, and content of reports as well as the number of copies, the language, and prospective recipients (without disclosing the names)>*

The Deliverable products are as follows:

1. Consultants Mobilization
2. Inception Report
3. Improved specifications for SHS and components
4. Improved test procedures for SHS and components
5. Fully functioning test facility
6. Documentation and reporting requirements as per [Code] standards
7. Sample certification reports for systems and components
8. Report on field monitoring and performance of SHS
9. Report on simulated SHS tests
10. Program Plan for achieving [Code] Certification
11. Monthly progress reports
12. Final report

## QUALIFICATIONS OF THE CONTRACTOR

The services of an experienced contractor organization will be required to provide the turn-key services described above. The organization must have demonstrated experience in PV systems design and installation, component and systems test procedures development, conducting tests under both laboratory and field conditions, and training staff. The organization must have proven expertise in preparing and implementing documentation, quality assurance and reporting procedures that meet [Code] requirements. The organization must have at least five years of experience in setting up and operating a PV Systems Testing Laboratory, and preferably operating Testing Facilities with [Code] or equivalent accreditation. Organizations with PV experience in developing countries will be preferred.

## COST ESTIMATE

The cost of services and hardware for the Technical Assistance is estimated at under [figure].